MONTANA STATE LIBRARY
3 0864 0015 5522 9

The Montana Energy and MHD Research and Development Institute, Inc.
Post Office Box 3809
Butte, Montana 59701
(406) 494-4569
FTS 585-2421

Presented to:
The Governor's Coal Gasification Task Force
December 17, 1976, at
Glasgow AFB, Montana

A FORECAST OF

MONTANA'S NATURAL GAS DEMAND TO 2000 AD

by

D. L. Brelsford, Manager
Environmental Engineering Division
The Montana Energy & MHD R & D Institute

Energy is a vital component in almost every aspect of modern man's life. Energy use has increased dramatically as populations have grown and lifestyles have changed to include energy consuming aspects such as: large climate-controlled living spaces, a high degree of mobility, varied and super abundant diets, and a supply of convenient or pleasing goods and services. We have become heavily dependent upon the concentrated and readily usable forms of stored energy.

The public's general attitude has been to assume that energy supplies will always be there when needed. It is an attitude based on experience.

Recent experiences have greatly changed the general outlook on energy. Embargoes, escalating costs, and alarmed forecasts of permanent, deepening scarcity have created widespread concern among officials, experts, and the general public. It now appears that serious energy shortages are definitely probable or even inevitable.

Suddenly it has become very important to learn as much as possible about future energy conditions. At least, we would like to know the magnitude of the problem that is developing. Hopefully, advanced knowledge will make it possible to choose policies that avoid or mitigate energy crisis conditions, such as the one herein projected to begin in 1985 in Montana.

As in many other regions of the country, the supply of natural gas in Montana may not be sufficient to meet future needs. One method to avoid this problem in Montana may be to produce SNG (synthetic natural gas) using the state's extensive coal reserves. The purpose of the study herein reported is to determine if SNG production may serve Montana's future natural gas demands and prevent an energy crisis from developing.

Determining the demand for SNG is essentially a balancing problem. The SNG demand is the additional production required to balance natural gas requirements with the supplies available. Thus, the demand for natural gas must be determined before the demand for SNG can be found. Natural gas cannot be considered alone as it competes with other fuels. Major conversion of industrial gas users to coal and electricity are certainly expected and will significantly affect the future demand for natural gas. The cost of producing SNG is likely to be different from the price of natural gas obtained from conventional sources. Thus, SNG may enter the marketplace and compete at different price levels than natural gas.

The forecasted demand for natural gas (including SNG) in Montana to 2000 AD, has been determined by the level of activity in the Montana economy.*

---

* "Montana Natural Gas Demand Study" by B. Jones, et al, Environmental Engineering Division, Montana Energy and MHD Research and Development Institute, Inc., Butte, Montana, December 1976.

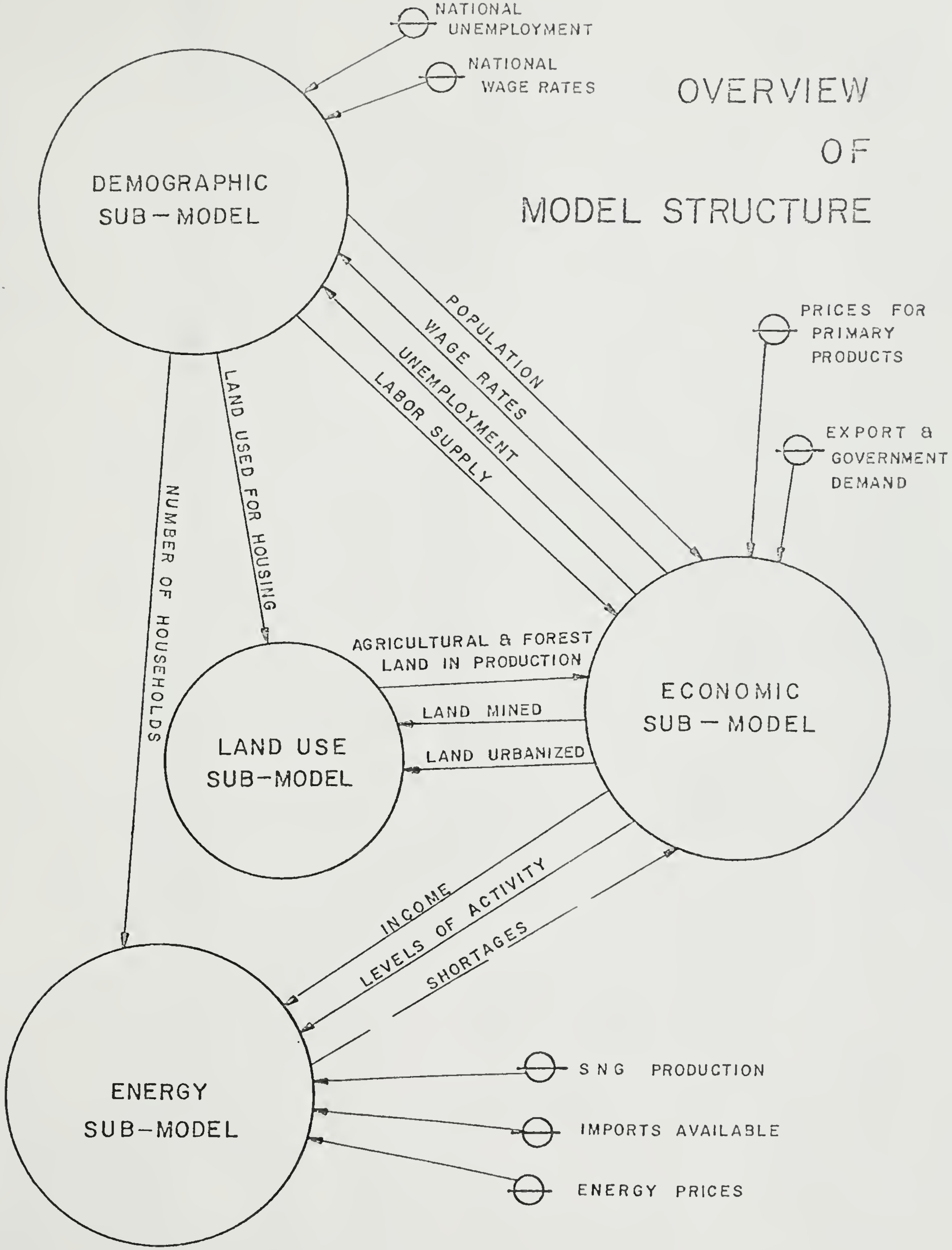
A dynamic systems simulation approach was selected as most appropriate for the model. This approach takes into account the various interrelationships and feedback effects found in the Montana economy.

The dynamic systems simulation methodology deals with the forces causing change in the economy and should be well suited for forecasting the transients which are likely to occur in Montana's future. It also allows the model to be based more closely on the actual processes and actions which occur in Montana's economy.

The model is composed of several sub-models, each dealing with a certain area of the economy. Overall structure for this model is illustrated in Figure 1. The model is similar in concept to the Oregon State Simulation Model, and the structure of some of the sub-models basically is the same as their Oregon counterparts. The Montana Futures Project input/output model of the Montana Department of Community Affairs also was used in the formulation of the model.

Each sub-model is discussed separately in the summary and full report. An effort has been made throughout the study to design the sub-models in such a way that they can easily be improved as additional information becomes available. In this manner, major model changes will not be required when better data are obtained.

Once developed, the model was used to analyze the effects of inter-fuel substitution and various energy conservation scenarios. Some industries in Montana recently switched from gas to other fuels, and more substitutions are projected for the future. Residential heating is a major gas use in Montana; conservation in that area was modeled for several projected gas price levels. Fuel substitution and energy conservation will be significant factors in the natural gas demand picture of Montana's future.



OVERVIEW OF MODEL STRUCTURE

Figure 1

SCENARIO PRESENTATION

Baseline Gas Demand in Montana

A baseline gas demand in Montana was established for the period between now and the year 2000 (see Figure 2). This baseline case represents a continuation of current policies and practices; in other words, business as usual. The baseline demand for natural gas assumes very little home energy conservation. Industrial fuel substitution is assumed to be minimal also.

In this case, the demand for natural gas is not considered to be supply or price limited. Significant overall economic growth is forecasted in Montana, but not all sectors of the economy will experience the growth. The petroleum industry and metal mining and processing are expected to provide a smaller proportion of economic activity in the year 2000 than now. This decline is due to a shrinking resource base and steadily increasing costs of extraction.

Forestry and kindred industries are expected to grow modestly but steadily through the end of this century. Agriculture will remain the dominant industry of Montana throughout the remainder of this century and shows significant economic growth. The coal industry should grow dramatically and will be the second largest industry in Montana by the year 2000.

The projections of Montana's economic future represented by the baseline case assume availability of adequate and economical energy supplies. In this case, natural gas demand represents a projection of energy demand currently being served by natural gas that could continue to be served by natural gas--assuming the supply is adequate and price would not constrain the demand.

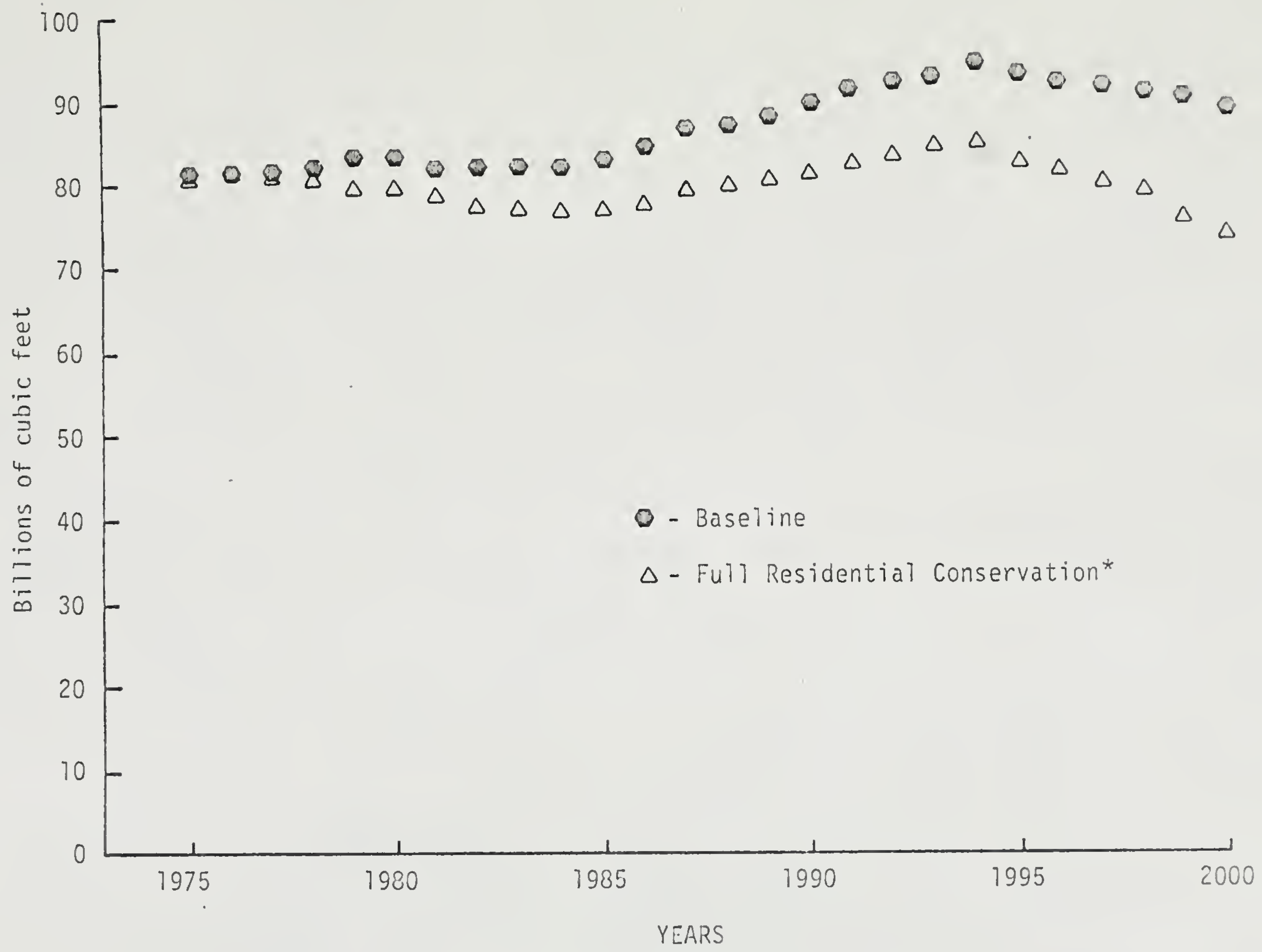


Figure 2.--Montana Natural Gas Demand

* Note: Natural gas price is assumed to rise from current levels to $4.50/MCF in 2000.

In subsequent cases to be presented and described herein, reduced natural gas demand is indicated to result from residential conservation, industrial conversion, price elasticities, etc. The indicated reduced demand in these various cases occurrs without any reduction in the projected economic activity of Montana (as long as adequate natural gas supplies are available to meet the projected demand). However, if the projected demand for any particular case exceeds the supply, an economic as well as an energy crisis will occur.

This mixed economic activity of the baseline case will change the proportion of demand supplied by various energy sources in Montana. One rather dramatic effect of this change is a much smaller increase in natural gas demand than has been experienced in the past. The natural gas demand for the baseline case would be 83 billion cubic feet in 1980 and approximately the same in 1985. Demand would be about 89 billion cubic feet in the year 2000, with peak demand in the mid-90's of around 94 billion cubic feet per year.

Residential Conservation Effects

The baseline case for gas demand assumes very little residential energy conservation. The first case to be considered after establishment of the baseline is the probable effect of significant home energy conservation. Since the greatest volume use of residential gas is in home heating, the focus was concentrated in this area. Reduced energy use per household is due to increased insulation, improved weather-stripping, and the use of storm windows and doors. Additional savings are realized from altered living habits. Home energy conservation primarily is a function of gas price.

Figure 2 shows the effect of home energy conservation on gas demand in Montana. The gas price is assumed to rise from current levels to $4.50/MCF in the year 2000. Gas demand approximates 80 billion cubic feet in 1980 and declines to 77 billion cubic feet by 1985. Demand for natural gas will be about 74 billion cubic feet in the year 2000, with a peak in the mid-1990's of approximately 85 billion cubic feet per year. Natural gas demand reductions that result from full residential conservation only are shown on Table 1, along with a comparison to recent projections of residential and commercial gas demand reductions from a staff report of the Montana Environmental Quality Council.

Industrial Energy Substitution

No industrial energy substitution is assumed in the baseline gas demand for Montana. The next step in the analysis is to see how substantial substitution of other fuels for gas affects gas demand. Fuel switches were divided into two types. First, industrial fuel substitutions considered firm are those that currently are underway or are scheduled for completion by 1980. These switches in fuel usage are caused by various factors such as environmental concern, fuel supply uncertainties, and relative fuel costs. Next, the industrial fuel substitution was extrapolated beyond 1980. The extrapolated fuel substitution is a function of relative fuel costs and the payback period for conversion.

The effects of both types of industrial fuel substitution are shown in Figure 3. One curve shows the effects of firm substitutions only, while the lower curve represents demand when firm substitutions and extrapolated substitutions are combined. The combined substitutions project a gas demand of 69 billion cubic feet in 1980. Demand falls off to 61 billion cubic feet in 1985 and is about 62 billion cubic feet by the end of this

TABLE 1.--MONTANA NATURAL GAS DEMAND REDUCTION (1)
BY FULL RESIDENTIAL CONSERVATION (2)

	RESIDENTIAL ONLY BY MERDI (BILLION CUBIC FT/YR)	RESIDENTIAL AND COMMERCIAL BY EQC(3) (BILLION CUBIC FT/YR)
1975	1	—
1980	3	5.7
1985	5	14.3
1990	8	18
2000	16	—

(1) FROM BASELINE CASE

(2) FULL RESIDENTIAL CONSERVATION IS DEFINED AS: 12" CEILING INSULATION, 4" WALL AND FLOOR INSULATION, DOUBLE PANE WINDOWS AND STORM DOORS.

(3) FROM 1975 AS SHOWN IN: "MONTANA NATURAL GAS SUPPLY CRISIS," BY THOMAS W. FRIZZELL, MONTANA LEGISLATURE, ENVIRONMENTAL QUALITY COUNCIL, HELENA, MONTANA.

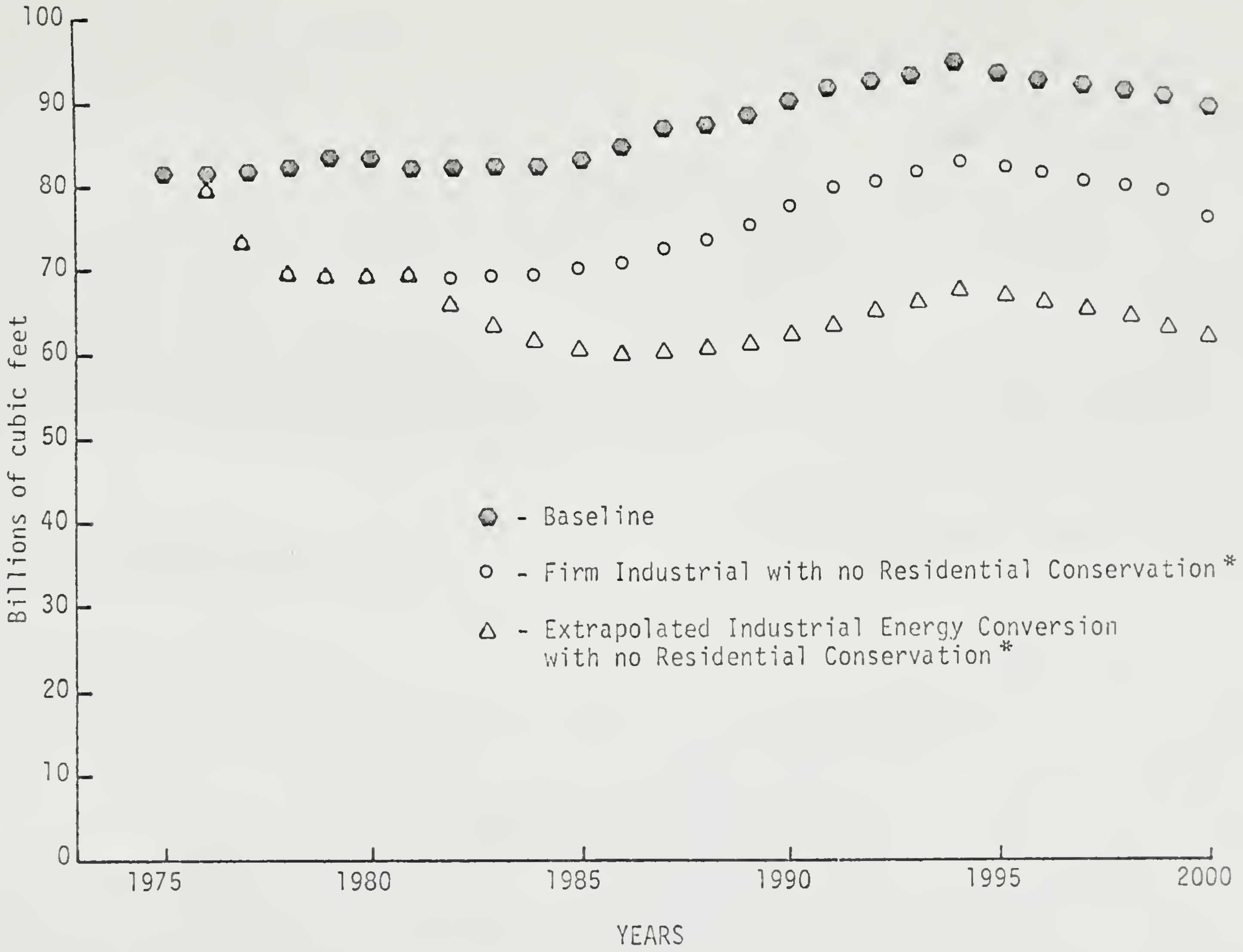


Figure 3.--Montana Natural Gas Demand

* Note: Natural gas price is assumed to rise from current levels to $4.00/MCF in 2000.

century. Peak usage in the mid-1990's is approximately 67 billion cubic feet. The price of gas is assumed to rise from today's prices to $4.00/MCF by the year 2000. Natural gas demand reductions that should result from industrial conservation and conversions only are shown on Table 2 with comparable projections from the recent EQC staff report.

Gas Price Effects

After showing the general effects residential gas conservation and industrial fuel substitution can have on gas demand, the SNG study group at MERDI used several gas price scenarios to determine a range of expected gas demands in Montana's future. Gas demand curves shown previously have assumed a rise in gas prices from the current level to $4.50/MCF in the year 2000.

Three price scenarios were selected as representative of low, medium, and high gas prices. Prices are for residential gas use; industrial gas prices were assumed to be lower by $.50/MCF. Figure 4 illustrates the gas demand expected at the specified price levels. Also shown on the graph is the baseline demand. Prices assumed for the low, medium, and high gas prices are shown in Figure 5. Table 3 summarizes the results shown in Figure 4.

As previously shown, full conservation in the residential and commercial sector of Montana's economy is expected to substantially reduce natural gas usage in individual residences and commercial buildings by 8 to 18 BCF/yr in 1990 (see Table 1). However, the projected economic activity in Montana will probably cause an overall increase in natural gas demand in spite of price increases for the residential and commercial sector as shown on Table 4. Demand in the residential and commercial sector is forecasted to

TABLE 2.--MONTANA NATURAL GAS DEMAND REDUCTION(1) BY INDUSTRIAL CONSERVATION AND CONVERSION

	BY MERDI (BILLION CUBIC FT/YR)	BY EQC(2) (BILLION CUBIC FT/YR)
1975	1	—
1980	14	11.0
1985	22	17.3
1990	28	21.4
1995	28	—
2000	26	—

(1) FROM BASELINE CASE

(2) FROM 1975 CONSUMPTION

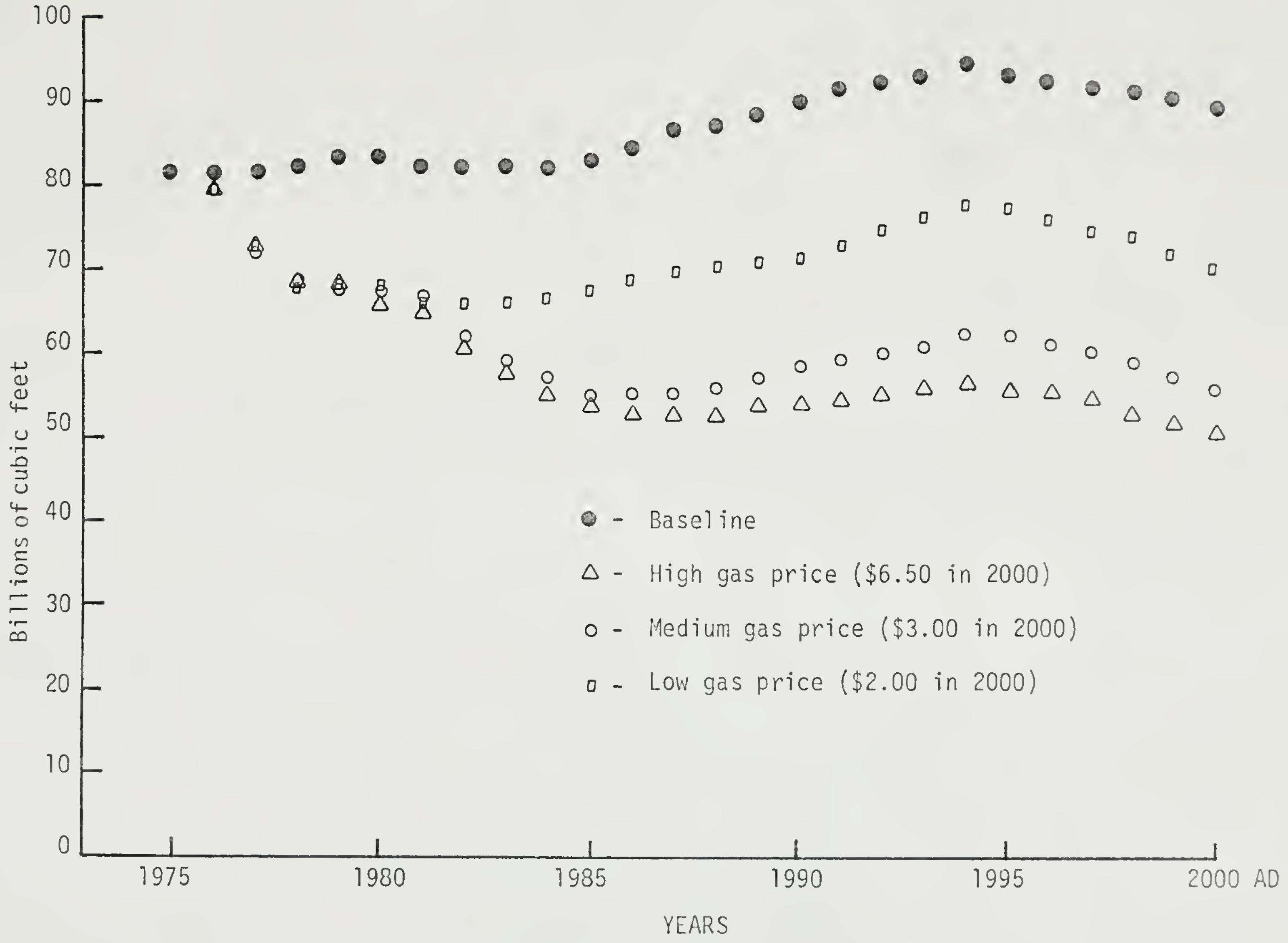


Figure 4.--Montana Natural Gas Demand

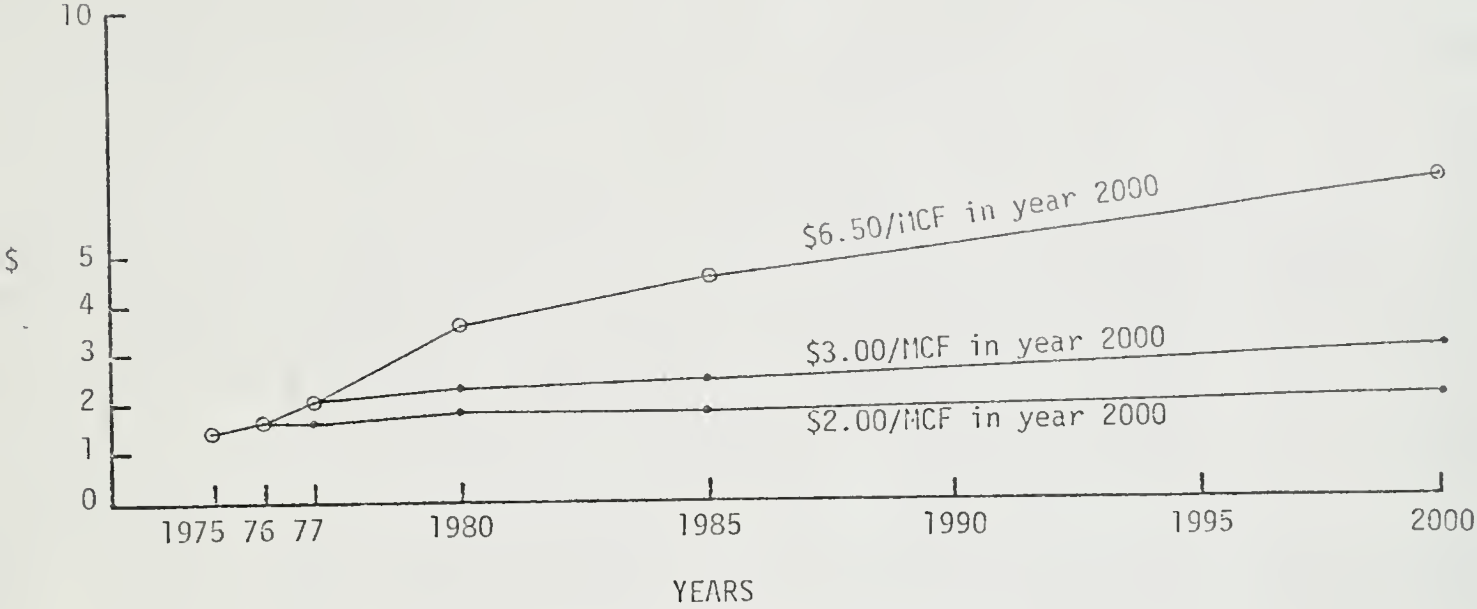


Figure 5.--Natural Gas Price Scenarios

Table 3.--Natural Gas Price/Demand Forecasts
(billions of standard cubic feet)

	PRICE		
Year	Low ($2.00 in 2000)	Medium ($3.00 in 2000)	High ($6.50 in 2000)
1980	67	67	66
1985	67	56	54
2000	69	55	51

TABLE 4.--MONTANA RESIDENTIAL & COMMERCIAL SECTOR NATURAL GAS DEMAND(1)

	RESIDENTIAL & COMMERCIAL DEMAND (BILLION CUBIC FT/YR)	PERCENTAGE OF TOTAL DEMAND %
1975	43	53
1980	37	55
1985	32	59
1990	41	72
1995	41	68
2000	35	66

(1) AT GAS PRICES OF \$2.00/MCF IN 1977 RISING TO \$4.50/MCF IN 2000 AD

increase toward a peak of 41 BCF/yr in 1990 and then drop to 35 BCF/yr in 2000.

Industrial demand for natural gas is highly price sensitive. Consequently, demand in the "industrial and other sectors" is forecast to decline from 38 BCF/yr in 1975 to approximately 18 BCF/yr in 2000 as a result of gas price increases from $2.00/MCF in 1977 to $4.00/MCF in 2000, as shown in Table 5.

Forecasted demand in response to substantial price increases has been presented in Table 4 for the residential and commercial sector and on Table 5 for the industrial sector. Their relative percentage of the total forecasted natural gas demand in Montana is also given on these tables as well as shown on Figure 6. This projection indicates that by 1985, this residential and commercial demand for natural gas will represent almost 60% of the total demand. By 1990, the industrial sector demand for natural gas is expected to drop to about 28% of the total.

Conclusions

Natural gas demand in Montana (including demand for SNG) will decline from the present level of about 80 billion cubic feet per year to 50-70 billion cubic feet per year by the year 2000. The decline in gas demand after 1980 is caused primarily by projected increases in the gas price to consumers. Even for modest increases in price (to $3.00/MCF in the year 2000), the demand is reduced by about 30% from current demand. A price of $3.00/MCF by the year 2000 is an average price growth rate of 2.5% per year. An average price growth of 5.75% (to $6.50/MCF in 2000) will drive gas demand down to about 60% of current levels by the year 2000.

TABLE 5.--MONTANA INDUSTRIAL & OTHER SECTOR NATURAL GAS DEMAND(1)

	INDUSTRIAL & OTHER DEMAND (BILLION CUBIC FT/YR)	PERCENTAGE OF TOTAL DEMAND %
1975	38	47
1980	30	45
1985	22	41
1990	16	28
1995	19	32
2000	18	34

(1) AT GAS PRICES OF $2.00/MCF IN 1977 RISING TO $4.00/MCF IN 2000 AD.

(2) EQC STAFF REPORT FORECASTS 30 BCF/YR OF DEMAND CAN BE MET BY SUBSTITUTE FUELS, ABOVE PROJECTION INDICATES 22 BCF/YR.

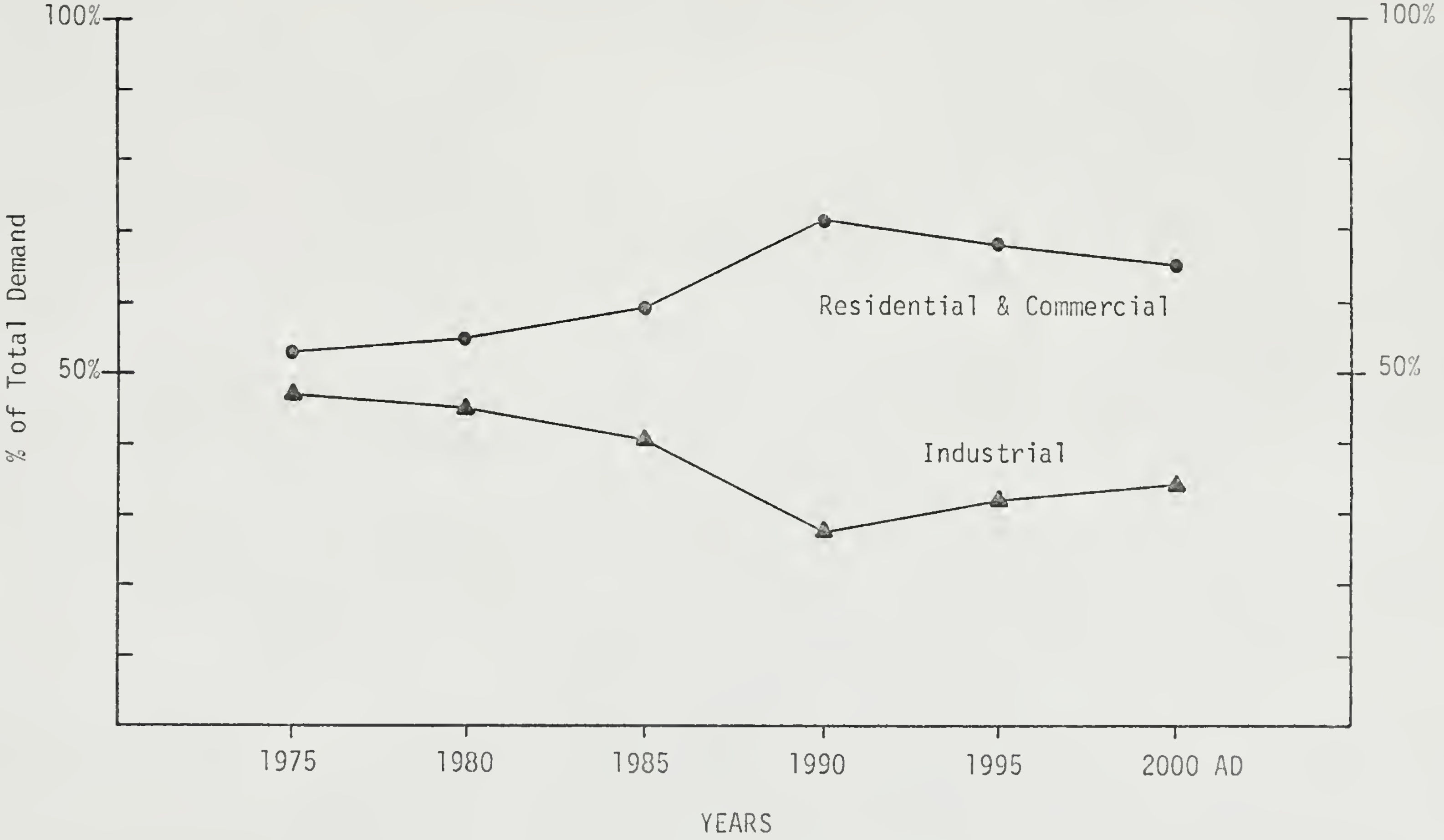


Figure 6.--Natural Gas Demand Distribution by Sector

It should be noted that the natural/synthetic gas demand projections shown here are probably maximum or "upper bound" estimates. Inter-fuel substitution for heating in the residential and commercial sectors was not modeled, nor was conservation in the commercial sectors. As the price of natural/synthetic gas increases in the future, these factors may become important and hence the demand for natural gas would be lower than that reported here. Unfortunately, the impact of these variables cannot be quantified at the present time.

Although we project a decreasing gas demand, our "most likely" projections still indicate a Montana natural/synthetic gas demand approaching 55-60 billion cubic feet per year in the year 2000.

The minimum available natural gas supply situation in Montana, as projected by the recent staff report of the Environmental Quality Council, indicate a substantial energy and economic crisis could occur about 1985. This projected crisis would result from an unsatisfied energy shortage previously satisfied by natural gas. One way to mitigate and possibly avoid this projected crisis would be to provide for SNG production in Montana beginning about 1985. On Figure 7 is shown the projected Montana SNG demand beginning in 1985. This forecasted demand calls for the production of 28 BCF/yr of SNG starting in 1985 with an additional 28 BCF/yr of SNG coming on line in 1992.

If this projected SNG demand is not satisfied by SNG production, its energy equivalent would have to be satisfied by alternate energy sources and systems. If this projected energy demand is not satisfied an economic crisis and social disruption in Montana should be expected.

It is important to realize that the forecast natural gas and SNG demand occurring after 1985 is relatively insensitive to the price of gas (see Figure 7). This fact indicates that some type of outside motivation or incentive will be needed to move these users to alternate energy sources. They will probably not move to alternate energy sources by their own motivation and finances.

SNG production in Montana, starting in 1985 could be a means to prevent an economic and social crisis as well as a way to "buy time" needed to develop and provide alternate, renewable energy sources for the residential, commercial and industrial sectors of Montana's economy beyond 1985.

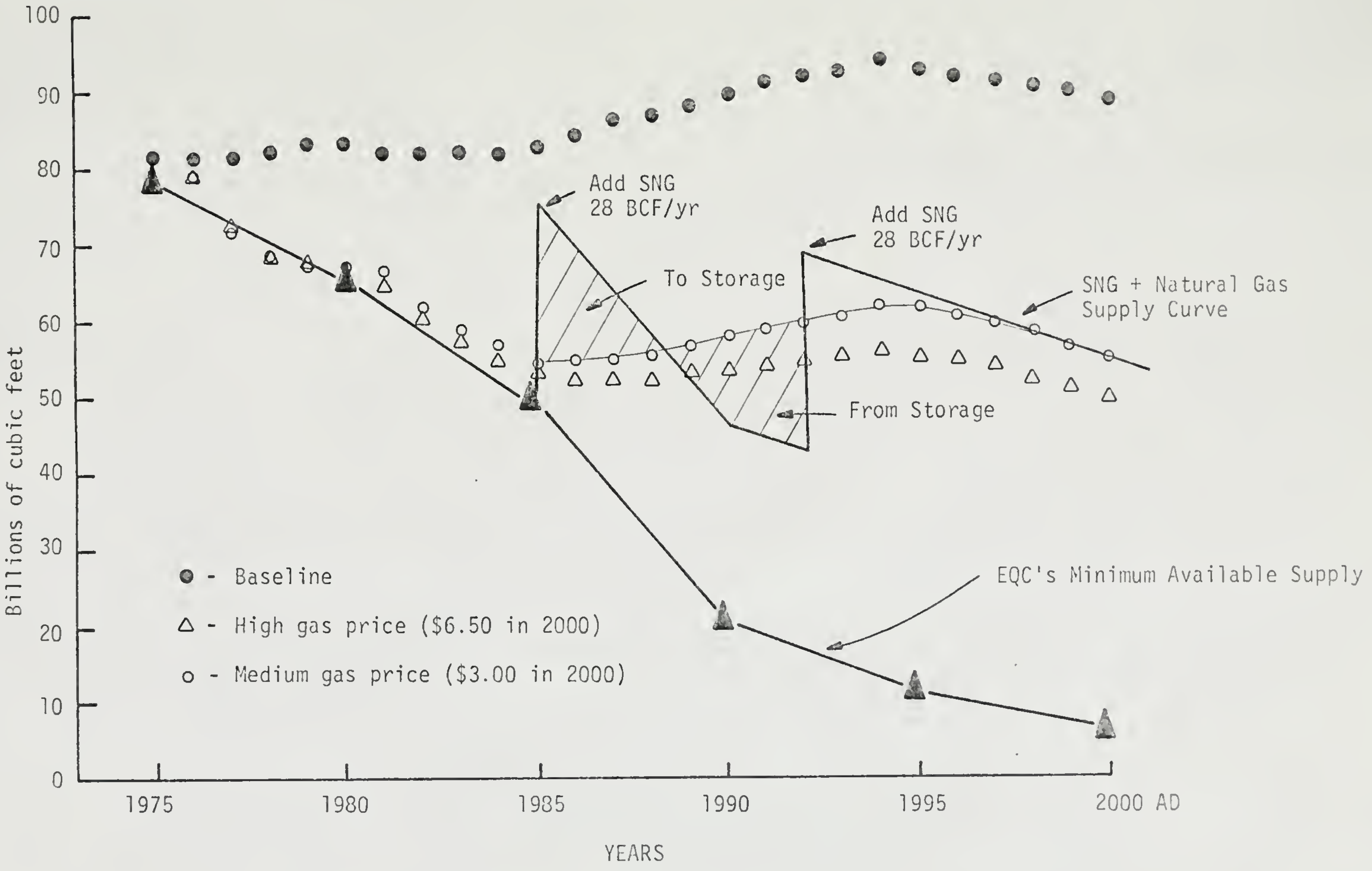


Figure 7.--Montana Substitute Natural Gas Demand